ENVIRONMENTAL RESEARCH PRIORITIES

1994

Ontario

Ministry of Environment
and Energy

ENVIRONMENTAL RESEARCH PRIORITIES

1994

ISSN 1192-4675

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INTRODUCTION

Background

The Ministry of Environment and Energy (MOEE) has undergone several changes in the past year. Among them is the relocation of the Research and Technology Section to the Fiscal Planning and Information Management Branch. One thing that has not changed, however, is that the Research and Technology Section (RTS) is still concerned with maximizing the benefits resulting from the environmental research and technology development funded by the MOEE. The Environmental Research Program is geared to support research work that will best serve the priority programs of the Ministry and to smooth the way to successful program implementation by facilitating the solution of those problems which impede their delivery.

In 1991, in order to properly discharge its mandate, the then Research and Technology Branch embarked on an initiative aimed at establishing its strategic directions for research by identifying the priority programs of the Ministry and the specific research questions in each program. The resulting document, entitled "Strategic Directions for Research and Technology - 1992" was intended to provide greater precision to the definition of research needs and thus better guidance to applicants in the formulation of proposals. Key topics and issues were identified in ten areas and linked to 17 Ministry programs. Despite this attempt to better define the Ministry's research needs, the applications received far exceeded the available funds.

As a result, in 1992, we investigated various avenues to further define its approach and thereby ensure that funding for environmental research is directed at those areas most closely matching Ministry policies and priority programs. Ministry staff were requested to identify specific research questions that needed to be answered immediately for the Ministry to deliver its programs. The research coordinators presented these as research objectives for 1993 at a Workshop held in late September 1992.

The objectives were reviewed with respect to the principles of pollution prevention, multi-media considerations and zero discharge, then screened in relation to the following criteria (not in order of importance):

- addresses MOEE priority
- environmental impact
- potential for partnerships with other researchers/agencies
- scope of work
- multi-program
- interdisciplinary
- potential for cost-sharing
- Ontario-based research
- specific timeframe for delivery.

The remaining objectives were then presented to the Research Advisory Committee to ensure consistency with Ministry policies and programs. The objectives that were approved were presented in the document "Environmental Research Priorities - 1993".

An approach similar to the one used last year was once again followed for review and screening of the submitted priorities. As a result, a number of research priorities have been selected and incorporated into this booklet for **1994 Environmental Research Priorities.** This document is the result of a more targeted research management process whose purpose is to ensure that funded projects contribute in a measurable way to the achievement of MOEE goals and objectives.

Environmental Research Priorities - 1994

Goals

All of the research objectives described in this document are intended to advance a specific Ministry **goal** and enable proposals to be identified with a specific Ministry program or strategy. Each **goal** is identified by a roman numeral.

Objective/Tasks

Under each goal, one or more specific research **"Objectives"** are listed. These are the specific questions to be addressed and are numbered as 1, 2, etc. Background information is provided describing the need for this research and relating it to the Ministry goal. The **tasks** that are subsequently assigned are only some recommended ways of achieving the objective and are not intended to limit research proposals but provide guidance to researchers.

Application for Funding

General application procedures and forms including information on eligibility criteria are included in the Funding Application Kits available from the **Grants Assistant** at (416) 323-4649. Specific questions on the Environmental Research Program can be addressed to the **Manager, Environmental Research and Technology Section** at (416) 323-4581 or the **Environmental Research Analyst** at (416) 323-4575. Questions on the specific research objectives described in this document should be addressed to the technical contact person indicated.

Your application should reference a **Goal** and **Objective** (i.e. I.1.) and if applicable the **Task** (i.e. I.1.a.) toward which your proposal is directed.

If your proposal does not meet a specific goal or objective, a ***notice of intent*** *form (copy available with the Application Kits described below) must be submitted for preliminary review.* Additional information on the notice of intent will be requested from the proponent, if warranted. A small amount (5% of available funds) will be directed towards proposals that do not address a specific goal or objective.

1994 Deadline for Submission

Completed application forms along with the detailed proposals must be received by January 21, 1994. *Notice of Intent* forms must, however, be received by December 17, 1993.

Evaluation Criteria for Funding Approval

Once proposals are received, the traditional administrative and funding aspects of the Environmental Research Program will be followed. Since funds are limited, even if a proposal addresses one of the research objectives outlined in this document, there is no guarantee that it will be funded. For some research objectives, no proposals may be deemed suitable for funding. Proposals will still be reviewed by technical and scientific experts according to the following criteria (not in order of importance):

- compatibility with Ministry priorities
- scientific and technical merit
- evidence of a multidisciplinary approach
- degree of collaborative arrangements between institutions and/or other groups
- competence of the researcher(s)
- quality of the facilities
- likelihood of achieving objectives on time
- potential for sharing costs with other organizations
- potential for implementation of results

With the limited funds available for research and the diverse nature of environmental research, the Environmental Research Program is actively promoting partnership arrangements between institutions, government agencies and the private sector. Research investigators are encouraged to incorporate a collaborative and/or multidisciplinary approach in their proposal.

RESEARCH OBJECTIVES

ACID MINE DRAINAGE

GOAL I

TO MITIGATE ACID PRODUCTION FROM MINING SITES TO PREVENT DAMAGE TO LARGE AREAS OF THE AQUATIC AND TERRESTRIAL ENVIRONMENT.

OBJECTIVE 1

To provide a comprehensive, scientific, technical and economic basis for the mining industry and government agencies to predict with confidence the long-term management requirements for reactive tailings and waste rock and to establish techniques that will enable the operation and closure of acid generating tailings and waste rock disposal areas in a predictable, affordable, timely and environmentally acceptable manner.

Background: A subset of mining sites in Ontario have waste rock, tailings (mill wastes) and mine workings that generate acids. The low pH associated with the reaction solubilizes toxic metals which are carried off the property. During operations, acids are neutralized to prevent impairment of water courses. After mine closure, passive systems are required to prevent acids from polluting the environment.

In 1988, spurred by industry, a national research organization called MEND (short for Mine Environmental Neutral Drainage) was established to oversee and coordinate research into acid mine drainage. In Ontario, research efforts related to acid mine drainage have been extended through an industry/government/university committee called MEND-Ontario (MEND-O). MEND-O works in close cooperation with the national body to ensure that overall goals are met.

Tasks:

a) Develop predictive techniques to determine the nature, mechanisms and extent of acid production in various environments.

b) Develop methodologies to prevent and control acid mine drainage from tailings, waste rock and workings.

c) Develop new methodologies to monitor operating, rehabilitated and abandoned acid generating sites.

d) Ensure timely transfer of information on acid drainage research to assist industry and government to solve the overall problem.

Application: Environmental protection from acid mine drainage.

Contact: Mr. D. Bazinet, Ministry of the Environment, (705-670-3246)
Mr. S. Reitzel, MEND-O Secretariat, (705-670-5819)

RESEARCH OBJECTIVES

AIR TOXICS

GOAL II

TO INVESTIGATE THE OCCURRENCE OF HIGH GROUND LEVEL CONCENTRATIONS OF OZONE IN SOUTHERN ONTARIO AND OZONE CORRELATION WITH EMISSION CONTROL - TO SUPPORT THE DEVELOPMENT OF NOx/VOC CONTROL STRATEGIES.

OBJECTIVE 1

To determine the relative importance of NOx, anthropogenic VOC and biogenic VOC in the formation of ozone. Also, to determine whether recent reductions in the emissions of the chemicals that produce ground level ozone have had any effect on ambient concentrations of ozone.

Background: Ground level ozone is a hazard to human health, and causes damage to agricultural crops. It is formed as the result of a complex series of chemical reactions in the atmosphere, involving the oxides of nitrogen and volatile organic compounds (VOC). These reactions occur only in the presence of sunlight. Because of the complexity of the reaction sequences, it is not possible to select an effective control strategy unless all of the details are understood. For example, reductions in the emission of NOx, one of the precursors, can, in certain circumstances, lead to increased concentrations of ozone. To complicate the picture, naturally emitted VOC are highly reactive with respect to ozone formation, but are not easily controlled.

In previous RAC projects, the concentrations of precursors, intermediates and products were determined for the atmospheric reactions which lead to the formation of ozone. The parameter list was longer than has been possible in most previous studies, and was designed to improve our understanding of the formation of ozone. For example, specific organic nitrates were determined; their formation is a direct indication of the participation of biogenic hydrocarbons in the reaction processes. A very valuable database of intensive chemical and meteorological measurements has now been collected. Additional work is now required to extract the maximum information and benefit from the datebase.

It is also necessary to investigate any trend in ground level ozone as a result of some of the control measures (for instance, lowering of Reid Vapour Pressure) taken both in the USA and Canada.

Tasks:

a) Continue analysis of data to determine inter-relationships between chemical and meteorological parameters and ozone formation.

b) Use selected data to improve current mathematical models of ozone formation and transport, and use the models to integrate and interpret the data in extension of Task (a).

c) Develop statistical tests to determine the influence of meteorology on the variability of ground level ozone.

d) Recommend statistical tests needed to analyse the trends in the ground level ozone data in Ontario and their correlation with reductions in Hydrocarbons and Oxides of Nitrogen emissions.

Application: The outcome of this work will be an improved understanding of the factors causing high ozone levels in Ontario, together with an improved modelling capability, and is therefore of great importance in the development of control strategies under the NOx/VOC Management Plan.

Contact: Dr. N. Reid (416-323-5224)
Mr. D. Fraser (416-235-5771)

GOAL III

DEVELOPMENT OF IMPROVED METHODS FOR ASSESSING PERSONAL EXPOSURE TO AIRBORNE TOXICS IN ORDER TO DEVELOP COST-EFFECTIVE CONTROL STRATEGIES.

OBJECTIVE 1

To design, develop and conduct cost-effective studies and strategies for the determination of personal exposure to airborne toxic chemicals to address human health implications.

Background: Outdoor monitoring data cannot be used for personal air quality and exposure profiles; essential data needed for risk assessment. Concentration levels of airborne toxics in a person's inhalation (breathing) zone are often several times higher than those reported from outdoor measurements and people normally spend less than 10% of their time outdoors. For acute (inhalation) health investigations, and a more realistic approach to risk determinations, effective abatement strategies and environmental standards settings, these profiles are urgently needed. For example, the appropriate guidelines and standards for personal air quality do not exist.

Tasks:

a) As part of the "Cities of the 90s" program, continue with the personal exposure studies in Hamilton as was originally set out in Windsor during 1991 and 1992. The Windsor personal air quality study dealt with the determination of airborne concentrations of Volatile Organic Compounds, Carbonyls and Trace Metals in a person's breathing zone and in the many different areas in which a person spends his/her time.

b) Continue with the development of new analytical and portable/light-weight sampling methodologies; in particular:
- Polyaromatic Hydrocarbons (PAHs), Pesticides and Radon gas
- Inhalable size fractionation of trace metals ($\leq 10\mu m$ and $2.5\mu m$)
- Hexavalent Chromium
- The classical contaminants such as NO_x, O_3, and CO

c) To develop a comprehensive and user-friendly data base for all personal air quality data.

Application: In support of risk assessment and source abatement strategies. Rather than expensive source abatement strategies, one may consider replacing or eliminating a product one uses; separate or isolate its source; or ventilate the area in which one works and lives. Education, public awareness and the re-evaluation of one's life-style may become the major endpoints for many future abatement strategies.

Contact: Mr. R.W. Bell (416-323-5171)

RESEARCH OBJECTIVES

ANALYTICAL TECHNIQUES

GOAL IV

TO DEVELOP ANALYTICAL METHODS IN SUPPORT OF HAZARDOUS WASTE SITE DECOMMISSIONING GUIDELINES.

OBJECTIVE 1

To develop a rugged, precise and accurate method for the quantitative determination of volatile organic compounds (VOCs) in solid environmental samples.

Background: At the 1991 meeting of the Canadian Council of Ministers of the Environment an interim guideline was prepared titled "Interim Canadian Environmental Quality Criteria for Contaminated Sites". The document detailed the allowable levels of target pollutants for various agricultural, residential and commercial sites.

For the class of compounds called VOCs, the chemical classes specified were: the chlorinated and non-chlorinated aromatic and aliphatic hydrocarbon solvents.

The document did not consider any of the other potentially hazardous volatile organic solvents that could be present at waste sites. Such chemical classes would include the following: ethers, esters, ketones, aromatic amines and alcohols.

Currently, MOEE does not have methodology for the quantitative determination of these compounds in environmental samples.

Tasks:

a) Develop methods for the quantitative determination of various chemical classes i.e. ethers, esters, ketones, aromatic amines and alcohols in different solid environmental samples.

Application: Provision of a standard analytical method for the determination of VOCs in environmental samples for use by industry.

Contact:

Mr. G. Kanert (416-235-5848)
Mr. T. Bright (416-314-7984)

GOAL V

TO AUTOMATE TECHNIQUES FOR MORE EFFICIENT ANALYSIS OF ENVIRONMENTAL SAMPLES.

OBJECTIVE 1

To test various alternative techniques for complex environmental samples containing chlorinated dioxins/furans, and evaluate the costs and performance improvements over the conventional methods.

Background: A series of newer techniques for clean-up of samples for dioxin/furan analyses have been suggested in the current scientific literature. These include the use of empore disks and fluid management systems. These techniques seem promising but attempts to automate them would bear the greatest return to our operations.

Although some work has already occurred within the scientific community and the laboratory to test out empore disks, additional work is required to test the best solvent mixes in order to improve efficiencies and recoveries of all toxic congeners. In addition, the automation of the test protocol would require additional effort and specialized machinery.

Tasks:

a) Test various solvent mixes in order to maximize recovery and improve efficiency of separation from interferents.

b) Design and set up fluid management systems in order to automate test protocols.

c) Test against manual systems.

Application: Provide a new, less costly test protocol for dioxins/furans.

Contact: Mr. E. Reiner (416-235-5893)

OBJECTIVE 2

To develop an automated method to enumerate bacterial colonies from membrane filtration procedures for the identification and counting of colonies resulting from the growth of bacteria on a standard microbiological plate.

Background: Counting colonies on microbiological plates is currently done manually, as is entry of the data into a database. Counting is somewhat subjective, both in accurate identification of colonies to be counted, and in distinguishing multiple colonies. Image analysis equipment currently on the market is not sophisticated enough to accomplish the needed identification and resolution of colonies, however the video technology and software can be brought to the needed capability.

Tasks:

a) Assemble the colour video and software components and install in a suitable configuration for plate counting.

b) Optimize the video and software parameters to give the best counting results.

c) Compare the image analysis system result with manually counted results using typical plates from daily workloads.

d) Improve the video system or the software in aspects revealed as deficient.

e) Develop the necessary links to the LIS/LIMS data systems.

Application: Counting routine microbiological plates such as membrane filters in an unattended mode, and for extended hours.

Contact: Mr. G. Horsnell (416-235-5886)

GOAL VI

TO DEVELOP ALTERNATIVE ANALYTICAL METHODS FOR TESTING ORGANIC LEACHATE FROM HAZARDOUS WASTES IN SUPPORT OF THE MINISTRY'S COMMITMENT FOR DEVELOPING LAND DISPOSAL RESTRICTIONS.

OBJECTIVE 1

To improve upon the U.S. Environmental Protection Agency's Toxicity Characteristic Leaching Procedure (TCLP) Zero-Head-Space for testing organic leachate from hazardous wastes with particular focus on volatiles.

Background: The Ministry of Environment and Energy is committed to develop land disposal restrictions for hazardous wastes and to expand the list of leachate toxic contaminants in Schedule 4 of Regulation 347. In both cases, concentration limits for organic contaminants will be set.

The present Leachate Extraction Procedure (LEP) included in Regulation 347 does not allow for testing of such organic parameters or volatile compounds. The U.S. Environmental Protection Agency's TCLP (Toxicity Characteristic Leaching Procedure) Zero-Head-Space is very costly and prone to equipment malfunction. The alternative is to develop a leachate extraction procedure which will improve upon both of these shortcomings.

Tasks:

a) Collect, homogenize and analyze typical waste samples;

b) Perform present LEP and TCLP Zero-Head-Space analyses (organics and inorganics) on waste;

c) Develop new procedures including expected user costs;

d) Implement new methodology and compare results to TCLP and LEP results.

Application: Incorporate into MOEE policy/legislation for waste characterization.

Contact: Mr. G. Castonguay (416-323-5214)
Dr. G. Kanert (416-235-5848)

RESEARCH OBJECTIVES

AQUATIC ECOSYSTEMS

GOAL VII

TO IMPROVE THE KNOWLEDGE OF AQUATIC ECOSYSTEMS FOR DEVELOPING TOXICITY STANDARDS.

OBJECTIVE 1

To develop physiological measures of stress in benthic invertebrates, including protocols for general and toxicant-specific biomarkers, as possible indicators of contaminant effects.

Background: Assessment and remediation of aquatic ecosystems are principally based on chemical guidelines, and are often supported by bioassessment procedures that identify changes to the community structure and populations of aquatic organisms. Within these bioassessment procedures provide useful general information on the impact of past events, they lack the ability to discriminate among the effects of various toxic chemicals or other environmental factors. Testing procedures that can discriminate among classes of compounds responsible for changes in community structure and provide dose-related information are the necessary next step in applying biological procedures that identify specific causes of problems and serve as "early warning" signals for the identification of emerging problems.

Tasks:

a) Conduct a comprehensive literature review of physiological indicators of contaminant stress on aquatic invertebrates.

b) Use the results of the literature review as the basis for selecting measures and tests approaches for development and testing as indicators of contaminants.

c) Where required, develop methods for the candidate test protocols, including calibration to a range of toxic compounds under a range of habitat conditions.

d) Conduct the candidate assays under a range of background (reference) conditions so as to identify target responses and to test the usefulness of the assay as an early warning indicator of stress related to anthropogenic factors.

Application: The protocols developed in this research could be used to define an "invertebrates health index" to be incorporated along with benthic invertebrate structure models, in biological guidelines for sediment management.

Contact: Mr. F. Fleischer (416-235-6222)

OBJECTIVE 2

To quantify the impacts of the exotic invader, the spiny water flea (*Bythotrephes cederstroemi*) on Ontario's inland lakes.

Background: The spiny water flea, *Bythotrephes cederstroemi* is large (1cm) predacious, European zooplankton that invaded each of the Great Lakes during the 1980's. The distribution of the invader in Europe suggests that it will spread widely across Ontario. Because we do not understand what controls the severity of the impacts of the invader, we can not predict its impacts on the aquatic ecosystems of inland lakes in Ontario.

Recently, the spiny water flea was found in several lakes in the District of Muskoka. These included three large recreational lakes (Muskoka, Rosseau and Joseph) with excellent fisheries records, and Harp Lake, a smaller recreational lake. Harp Lake has been studied for almost tow decades as part of the Lakeshore Capacity Study and Acid Precipitation in Ontario Study. These data sets provide an excellent opportunity to document the impacts of this invader on the open waters of Ontario's lakes.

Tasks:

a) Identify the preferred prey of the spiny water flea in inland lakes;

b) Quantify the predation rates of the spiny water flea on these prey, using laboratory or field experiments and/or bioenergetic models;

c) Quantify the demographics (life history parameters and growth) of the preferred prey of the invader in selected inland lakes;

d) Predict the impacts of the invader on their prey by comparing prey production and consumption rates, and

e) Test the predictions by comparison of pre- and post-invasion community structure in Harp Lake.

Application: Establish the need for a program to minimize the spread of the spiny water flea.

Contact: Dr. N. Yan (705-766-2418)

RESEARCH OBJECTIVES

BIOREMEDIATION

GOAL VIII

TO DEVELOP MODELS AND METHODOLOGIES FOR EVALUATING BIOREMEDIATION PROCESSES.

OBJECTIVE 1

To carry out performance evaluation of ex-situ bioremediation of contaminated media.

Background: Ex-situ bioremediation technologies are frequently selected for remediation of sites contaminated with hazardous wastes. In Canada, many of the contaminated sites inventoried may ultimately be remediated using ex-situ bioremediation treatment technologies. Proper guidelines for conducting performance evaluation of single and/or multiple-process ex-situ bioremediation treatment systems on heterogenous contaminated media are currently lacking.

Tasks:

a) To develop cost-effective methodologies for performance evaluation of ex-situ bioremediation of contaminated media.

b) To generate guidelines for the design of sampling programs for use in performance evaluation of ex-situ bio-treatment systems.

c) To establish the feasibility of developing appropriate software tests to enhance the use of performance evaluation guidelines and develop appropriate software tools.

Application: In support of technology development for site remediation.

Contact: Mr. U. Sibul. (416-323-5182)

OBJECTIVE 2

To develop a model to predict acclimatization periods for microbial populations in different types of soils exposed to a variety of petroleum hydrocarbons and other organic contaminants.

Background: An acclimatization period is normally required for microbial populations when exposed to petroleum hydrocarbon contamination in soils. The acclimatization period is generally unknown and may depend on many factors including concentration of contaminants, types of contaminants and ecology of all original microbial population. Knowledge of the acclimatization period is important in bioremediation applications, mainly for determining whether petroleum hydrocarbon degrading microorganisms might need to be seeded or not.

Tasks:

a) Development of a predictive model to be used in determining acclimatization periods and whether the introduction of degrading microorganisms would be successful or not.

Application: Technology development for site remediation.

Contact: Mr. U. Sibul (416-323-5182)

RESEARCH OBJECTIVES

DRINKING WATER

GOAL IX

TO IMPROVE KNOWLEDGE OF WATER TREATMENT PROCESSES FOR THE DELIVERY OF SAFE, ADEQUATE QUANTITIES OF DRINKING WATER.

OBJECTIVE 1

To understand the causes of preventing the formation of N-nitrosodimethylamine (NDMA) in the conventional water treatment processes.

Background: NDMA is a carcinogen with an Ontario Interim Drinking Water Objective of 9 ppt. Two years ago NDMA was discovered in the treated water in the Ohsweken water supply. It was subsequently determined that the NDMA was being formed in the conventional drinking water treatment process used in the plant. Conventional and novel modifications to the treatment process would not prevent the formation of NDMA. A treatment system has been installed using ultraviolet light to destroy the NDMA after formation. This is a solution that allows the town to again drink the water, however the ultimate solution has to be the determination of the NDMA formation mechanism and the prevention of NDMA formation.

Tasks:

a) Refine analysis of the precursor dimethylamine (DMA).

b) Subject DMA to conventional treatment processes to produce NDMA.

c) Describe NDMA formation mechanism.

d) Explain ways of preventing NDMA formation.

Application: The solution is directly applicable to the Ohsweken water plant and possibly to other water supplies in Ontario and beyond. The understanding of the chemical treatment process will better equip the MOEE to deal with water treatment problems in the future.

Contact: Mr. R. Hunsinger (416-235-5822)

OBJECTIVE 2

To study biological parameters for the delivery of safe, adequate quantities of drinking water.

Background:

Of all the concerns regarding drinking water quality, those of paramount importance are ones affecting human health. Of these microbiological/macrobiological parameters, which can affect health in an immediate (acute) bias are most important.

Recent identified (within the last 5-10 years) protozoan parasites such as *Cryptosporidium* and *Gardia lamblia* have been associated with disease outbreaks.

There are a number of need associated with understanding control and identification of these parasitic organisms. This was recently (Spring 1993) illustrated by outbreaks in both Milwaukee, Wisconsin and the Regional Municipality of Waterloo, associated with *Cryptosporidium*. The incident in the Milwaukee resulted in 35 deaths; about 200 people were affected in Waterloo with apparently no serious long-term effects. In Milwaukee the drinking water leaving the plant met all US EPA criteria and thus it is apparent that much more knowledge is needed regarding these parasites.

Tasks:

a) Develop identification and enumeration methodology which will be consistent across the drinking water industry.

b) Investigate the background levels in the population and develop risk levels (concentrations) which can be goals for treatment.

c) Evaluate disinfection/removal methods.

d) Develop on-line monitoring either for the parasites or more likely surrogates to maintain removal efficiency.

Application: Provides assurance of safe drinking water.

Contact: Dr. K. Roberts (416-235-6250)

RESEARCH OBJECTIVES

ENVIRONMENTAL SOCIO-ECONOMICS

GOAL X

TO IMPROVE FUTURE POLICY/PROGRAM DESIGN AND EVALUATION BY RESEARCHING THE QUANTITY AND VALUE OF BENEFITS ASSOCIATED WITH PAST ENVIRONMENTAL PROTECTION PROGRAMS AND ACTIVITIES.

OBJECTIVE 1

To identify, quantify and value both public and private benefits associated with selected environmental protection programs and activities, and to produce reference reports on the quantitative amounts of public and private benefits achieved over the past 20 years.

Background: Environmental public policies and programs should yield benefits that are perceived to be commensurate with their costs. Benefits consist of private benefits, such as reduced costs or increased revenues realised by regulated parties who bear the costs of protection activities, and public benefits such as reduced human health effects, increased recreational opportunities, reduced ecosystem damages, reduced costs of air or water treatment and enhanced quality and enjoyment of environmental resources. These benefits can be quantified using dispersion models, dose-response relationships and data on resources and populations at risk. Where benefits are associated with marketed goods and services, or where other methods are available to estimate willingness to pay for improvements, benefits may be valued in monetary terms.

Methods and procedures for identifying, quantifying and valuing public benefits have been applied by and for the Ministry to a number of proposed programs and initiatives. (See for example, Donnan, J. *Mercury Pollution in the Wabigoon-English River System - A Socio-Economic Assessment of Remedial Measures*, 1986; *The Economics of Acid Precipitation: A Review of Socio-Economic Methods to Assess Acid Deposition Effects*; and *Economic Assessment of Proposed Revisions to Regulation 308 - Synthesis Report*, 1990. These and other studies have focused on forecasting the potential benefits of proposed programs, policies or projects.

Few retrospective (*ex post*) studies have been carried out to document the public or private benefits of environmental protection programs that have been implemented. Partly this stems from the difficulty in separating effects of environmental protection programs for other factors and circumstances that impinge upon the issues.

The Ministry is interested in studies to assemble and examine existing data on past actions and subsequent changes that can be used to identify, quantify and value the benefits associated with selected programs and policies, to be chosen in consultation with the Ministry.

The Ministry welcomes proposals that involve partnerships and joint funding arrangements with other interested organizations.

Tasks:

a) Review past work and relevant research.

b) Define appropriate procedures and protocols for conducting an ex post or retrospective assessment of benefits.

c) Select initiatives, policies and programs on which to focus analyses.

d) Propose specific methods and procedures to identify, quantify and value (or weight) public as well as private benefits associated with MOEE programs and activities in the past.

e) Apply systematic formats and procedures to collect program impact data, estimate quantities benefits realized, and value these benefits in monetary terms.

f) Apply appropriate dose-response functions and models to produce estimates of reduced environmental damages and/or increased opportunities associated with environmental improvements, and specify the degree of uncertainty associated with each estimate.

Application: The reference reports obtained as a result of this work can be updated and extrapolated with new programs and initiatives and used in Environmental Statistics and State of the Environment Reporting.

Contact: Dr. J.A. Donnan (416-327-1337)

GOAL XI

TO IMPROVE UNDERSTANDING OF THE ECONOMIC BENEFITS OR LOSSES OF EXISTING ENVIRONMENTAL REGULATION.

OBJECTIVE 1

Determine the impact on economic activity that results from the response of industry, business and individuals to specific regulatory approaches to environmental protection.

Background: Regulatory approaches to environmental protection have led to significant improvements and are favoured as offering a degree of certainty with respect to their environmental effects.

Advocates of regulatory approaches also contend that significant economic benefits are derived from their imposition. Others contend regulations impose dead weight losses on the economy, particularly on some sectors.

The firms and economic sectors that are the targets of regulation have choices in how to respond. These choices have significant impact on the economic effects that flow from regulations, but some responses may have significantly better or worse economic impacts while arriving at the same environmental end.

Tasks:

a) Select a particular regulatory scheme and investigate by case study or other method the economic impacts of various responses to implementing the regulations. Regulations with several years history of enactment are preferred.

b) Assemble a database on the response of the decision makers in the affected industries and an assessment of their actions to comply.

c) Analyze with appropriate economic models changes in investment, employment, production, sales and other indicators that can be attributed to regulation.

d) Prepare reports on the research results including quantitative analysis of the responses and an assessment of the economic benefits or losses.

Contact: Mr. R. Chute (416-327-1402)

GOAL XII

TO MEASURE PROGRESS TOWARDS SUSTAINABILITY THROUGH THE USE OF SUSTAINABILITY INDICATORS.

OBJECTIVE 1

Define and test sustainability indicators for selected economic sectors.

Background: Much theoretical work has been done on the concept of sustainable development and related indicators. No generally accepted theory has been agreed upon, but several frameworks have been advanced or are under development that could be applied to define and test indicators that may be useful as measures of sustainability. At a minimum, the more advanced frameworks link together such concepts as ecosystem integrity, economic sustainability and the broader needs of human well-being.

The Ontario Round Table report, "Restructuring for Sustainability (1992)", recommended the development of indicators that measure progress towards sustainability. The research proposed here will contribute to the work on indicators by developing methods and criteria with which to judge sustainable development, or more precisely "sustainable economic activity", in selected economic sectors.

The Ministry welcomes proposals that may extend the scope of work envisaged by this project through partnerships and joint funding arrangements with other interested organizations.

Tasks:

a) Identify, in consultation with the Ministry of Environment and Energy and other partners, as appropriate, the economic sectors to be studied.

b) Define potential sustainablilty indicators on the basis of relevant theory or criteria.

c) Gather data and other information needed to quantify the sustainability indicators using the proposed conceptual and analytical framework.

d) Organize and run a multi-stakeholder focus group session to review and critique the framework, methods, criteria and proposed indicators.

e) Incorporate the results of the focus group session and revise the framework, methods, criteria and indicators, accordingly.

Contact: Mr. K. Ogilvie (416-323-4466)

GOAL XIII

TO INCREASE MINISTRY'S ABILITY TO ANTICIPATE AND RESPOND TO PUBLIC CONCERNS ABOUT ENVIRONMENTAL RISK.

OBJECTIVE 1

To develop a concise framework, based on a social science model of risk assessment, that will assist the Ministry in anticipating and responding to public perception of environmental risk in Ontario.

Background: Social science research indicates that the public evaluates risk in different terms than do scientific experts. They do not view risk in terms of calculated probabilities of mortality/morbidity, but in terms of values like visibility, controllability, catastrophic potential and familiarity. Thus, in contrast to technical experts, the public may perceive activities like driving or smoking as relatively low risk and activities like flying or drinking tap water as high risk.

The discrepancy between expert and public assessments of risk can complicate efforts to allocate scarce Ministry resources, to address areas where risk is not publicly perceived, to satisfy public concerns where risk is perceived, to communicate, to obtain public input, support and cooperation and, ultimately, to serve the public interest in a manner consistent with public expectations.

Incongruity between public and technical perception of risk may be more effectively bridged through refining and reorienting Ministry approach to risk management and risk communication to account for the "social values" component of risk perception.

Tasks:

a) Evaluate the effectiveness of social science approaches to risk assessment which incorporate "social values" against technical models which ignore this component of risk, by using case studies of environmental issues in Ontario.

b) Identify the key factors affecting the difference in public and technical assessment of risk with regard to environmental issues in Ontario.

c) Develop a framework that will help the Ministry apply this social science approach to risk assessment in program development, planning and communication.

Application: The resulting framework can be used in improving the effectiveness of Ministry response to major environmental issues and events.

Contact: Mr. A. McAllister (416-323-4355)

RESEARCH OBJECTIVES

HAZARDOUS WASTES

GOAL XIV

TO ENSURE THAT THE INCINERATION OF WASTE MATERIALS IS CONDUCTED IN AN ENVIRONMENTALLY SAFE MANNER.

OBJECTIVE 1

To provide for the safe management of de-inking sludges and to minimize emissions from its incineration.

Background: Large amounts of deinking sludges are produced in Ontario. For example, the Atlantic Packing plant produces about 100,000 tonnes of de-inking sludge per year. The Ministry has concerns with incinerator emissions but operating parameters for de-inking sludge incinerators have not been developed. Incinerator technology, operational parameters and methods of operation are significantly different than MSW or hazardous waste incinerators.

Full-scale pulp and paper sludge incinerators in Ontario are not suitable for a test program due to their use of multiple fuels, size and lack of operation variability. Use of such a facility would result in prohibitively expensive modifications and testing. New facilities would likely use state-of-the-art fluidized bed incinerators; thus, testing on full-scale pulp and paper sludge incinerators would be irrelevant.

Tasks: By performing the following tasks, develop optimal operating parameters to minimize emissions:

a) do chemical analyses of typical sludges with emphasis on dioxins/furans and heavy metals and possible analysis of leachate toxicity of ashes.

b) test burn samples under various conditions of temperature and retention time to determine typical emissions such as particulates, $C0$, $C0_2$ and 0_2.

c) recommend development with particular application to three wood/sludge burning projects now being developed by industry.

The parameters developed may then be incorporated into MOEE policy/legislation.

Application: In support of sludge disposal regulations.

Contact: Mr. G. Donnelly (416-323-5130)

GOAL XV

TO IMPROVE KNOWLEDGE BASE OF LANDFILL GAS EMISSIONS AND THEIR IMPACT ON THE COMMUNITY.

OBJECTIVE 1

To develop a model to estimate site specific landfill gas and trace organic emissions from different landfill design and operation.

Background: The rate of methane, carbon monoxide and trace organics generated and emitted from landfills are dependent on many factors including moisture content in the landfill; design (ie. with and without gas control) and operation of the landfill; and type of waste disposed of in the landfill. Knowledge of landfill gas and trace organic emissions is important in the evaluation of the health and odour impacts from landfills.

Tasks:

a) Develop or refine a predictive model to determine the site specific landfill gas and trace organics emission rate, taking into account site specific parameters such as moisture content, landfill design and operation.

Application: Evaluation of Landfill Gas Emissions on the Community.

Contact: Mr. E. Loi (416-323-5146)

RESEARCH OBJECTIVES

INDUSTRIAL EFFLUENTS

GOAL XVI

TO DETERMINE THE IMPACT OF POLLUTION CONTROL TECHNOLOGIES ON ZERO DISCHARGE OF PERSISTENT TOXIC SUBSTANCES.

OBJECTIVE 1

To determine if the Best Available Technology Economically Achievable (BATEA) under MISA eliminates the bioaccumulation of persistent toxic substances in fish resident in the receiving waters.

Background: BATEA for bleached kraft mills includes the use of 100% chlorine dioxide, oxygen delignification, secondary treatment and enhanced fibre washing. It is not clear if this technology eliminates the formation of dioxins and furans, nor is it clear what level of other organic toxicants are formed which are resistant to breakdown in the secondary treatment system (persistent).

Regulation of BATEA rests largely upon the measurement of AOX, leading to the perception among many that AOX is itself toxic. Investigations on whether AOX is persistent, toxic and/or bioaccumulative need to be undertaken to determine if, by meeting these three criteria, AOX should be subject to zero discharge.

The assessment of pulp mill toxicity is complex, because of the tremendous technical issues regarding the make-up of AOX, and the impact of various plant processes on chemical composition and impacts. The only way to address these factors is to deliberately target a BATEA facility for intensive investigation, and in particular to focus on the issue of sediment/particle associated bioaccumulative compounds which are likely candidates for zero discharge.

Tasks:

a) Investigate in detail, with state-of-the-art analytical technology, the levels of dioxins, furans, chloroguaiacols, chloroveratroles, chlorophenols, vanillins and syringols, as well as "emerging pollutants" in predatory fish and sediments (bottom and suspended) upstream and downstream of a BATEA facility, including the modelling of BAF's from these two compartments.

b) Assess the persistence of AOX in the river downstream of a BATEA facility, including the levels of AOX as Extractable Organic Halides (EOX) in sediments, and investigate under laboratory conditions the persistence, bioaccumulation and reproductive toxicity of AOX/EOX from these sediments to fathead minnows over two generations (150 days).

Application: Provides rationale for the elimination of molecular chlorine and chlorine dioxide from bleached kraft mills in Ontario.

Contact: Dr. I. Smith (416-314-7996)

GOAL XVII

TO INVESTIGATE THE USE OF INNOVATIVE METHODS TO REMOVE TOXIC CONTAMINANTS IN WASTEWATER.

OBJECTIVE 1

To determine the effectiveness of the freeze crystallization (FC) process treating hazardous contaminants in industrial wastewaters.

Background: The process for concentrating dilute streams by refrigeration techniques seem to be getting the most attention in the following three areas: treating hazardous chemicals in industrial wastewaters; purifying organic chemicals and concentrating fruit juices; and separation of contaminants from water enables plants to recover used water and achieve zero discharge.

Crystallization has traditionally competed with distillation and evaporation. The FC can freeze a pound of water using only about 150 BTUs, but 1000 BTU are needed to boil it. The FC operation:

- prevents corrosion problems,
- odours from spreading (compared to evaporation),
- requires the use of standard materials, and
- requires a lot less chemical reagents

A wastewater is cooled to below its freezing point, which solidifies and purifies the water as solute concentrates in the remaining liquid. There are new direct-contact refrigeration cycles that are 50% more efficient than traditional ones, crystallizers and crystal washers that enable production of ultrapure chemicals (99.99+%) and permit throughput as high as 150 million lb/yr (about five times higher than previously reported).

Tasks:

a) Complete a literature review on the FC process and its applications to date. Investigate in detail the published performance data relative to removal of hazardous chemicals (organic and inorganic) from industrial effluents.

b) Initiate a bench-scale study to look into the feasibility of using FC on the various industrial effluents under enclosed (controlled) and outdoor (natural) conditions. The wastewaters taken into consideration would be from: pulp and paper, refinery, organic and inorganic chemical processing plants and metal casting and metal finishing plants.

c) Use the promising bench-scale results and initiate a pilot-scale study. Scale up the equipment design parameters and investigate the feasibility of FC process use and the total used water recycle.

Application: The results will give plants an incentive to invest into the installation of FC process to replace the distillation and evaporation processes. The FC process will in the long run provide savings in water consumption and success in pollution prevention.

Contact: Mr. E. Turner (416-314-3933)

RESEARCH OBJECTIVES

PEST CONTROL

GOAL XVIII

TO REPLACE THE USE OF ENVIRONMENTALLY HARMFUL PESTICIDES WITH METHODS OF PEST CONTROL THAT ELIMINATE OR REDUCE THAT HARM.

OBJECTIVE 1

To eliminate and/or prevent the use of pesticides that cause damage to the environment through contamination of water, air, or soil and/or impact on wildlife and human health and to promote the use of those that are environmentally benign.

Background: Much is known about the pesticides developed in the 1960s and 1970s but new pest control materials have different modes of action, smaller use rates, etc. Research is necessary to better define the fate of many of these agents in the soil, water, air and biological components of the environment.

Tasks:

a) Develop and adapt analytical techniques to follow the metabolic fate of pesticides applied to soils and vegetation be they herbicides, fungicides or insecticides.

b) Prepare balance sheets on the environmental fate and impact of soil, vegetation and fumigant applied pesticides, partitioning into the soil, water, air and biological compartments.

c) Adapt analytical techniques to follow the metabolic fate of pesticides applied to water or contaminating water.

d) Study the environmental impact of pesticides on non-target species and determine recovery.

e) Study the fate of carbaryl in aquatic systems of the Laurentian Shield.

f) Develop integrated pest management protocols for buildings and structures.

Application: Changes in classification of products; changes in regulation.

Contact: Mr. D.J. Mewett (416-314-9235)

GOAL XIX

TO SUPPORT THE ONTARIO MINISTRY OF AGRICULTURE AND FOOD'S FOOD SYSTEMS 2002 PROGRAM WHICH AIMS TO REDUCE THE USE OF CHEMICAL PESTICIDES BY 50% BY THE YEAR 2002.

OBJECTIVE 1

To replace single strategy pest control with integrated pest management strategies.

Background: There is a growing concern about the present reliance on synthetic chemicals for pest control in agriculture, and research is necessary to look at all aspects of pest control with a view to reducing the inputs of chemicals using an integrated approach. This can be accomplished by developing biological and other non-chemical pest control techniques and alternatives to either augment or replace present practices.

Tasks:

a) Develop threshold population values for control actions and improved methods to monitor pest populations.

b) Investigate exotic biological control organisms that could be introduced into the Ontario environment to replace synthetic pesticides.

c) Evaluate biological chemicals as replacements for environmentally harmful chemicals in the control of disease, insect, weed and rodent pests.

d) Discover natural biological control organisms present in the Ontario environment that could be successfully used to replace chemical techniques.

e) Develop cultural and application alternatives for environmentally harmful pest control methods.

Application: Changes to OMAF recommendations; modifications of MOEE regulations and classifications.

Contact: Mr. D.J. Mewett (416-314-9235)

GOAL XX

TO ENSURE THAT THE PESTICIDE INDUSTRY DEVELOPS AND IMPLEMENTS METHODS OF PESTICIDE CONTAINER DISPOSAL (REDUCE, REUSE, RECYCLE) THAT ARE SAFE TO THE ENVIRONMENT.

OBJECTIVE 1

To determine the rate of migration, diffusion or leaching of contaminants from plastic resins previously containing pesticides to ensure that residues do not inhibit the potential to recycle.

Background: In keeping with the ministry thrust to reduce, reuse and recycle as well as to prevent pollution, this research would look at the area of pesticide container disposal, where it is becoming more and more difficult each year to find suitable disposal methods and locations. Criteria are necessary to determine where this waste can best be used in a safe manner.

Tasks:

a) Determine the fate of pesticides when plastic pesticide containers are recycled.

b) Develop criteria for uses of recycled plastic from pesticide containers (i.e drainage tiles).

c) Determine the persistence and bioavailability of pesticides in recycled plastics.

Application: Development of guidelines/regulations; useful products from recycled pesticide containers.

Contact: Mr. D.J. Mewett (416-314-9235)

RESEARCH OBJECTIVES

RISK ASSESSMENT

GOAL XXI

TO IMPROVE MULTIMEDIA RISK ASSESSMENT NECESSARY FOR STANDARDS DEVELOPMENT.

OBJECTIVE 1

To develop/adapt physiologically based pharmacokinetic models to improve understanding of the internal doses of active species at target organs in relation to the potential health effects under non-uniform exposure conditions.

Background: Question about the effects on human health of variable exposure patterns, especially with respect to exceedances of health based limits (which are usually based on long-term exposures) are frequently asked but cannot be reliably answered with available information and models. This lack of information impedes the formulation of risk management schemes, such as control of emissions to air, water and soil.

Tasks:

a) Use existing PB-PK models to simulate continuous exposure conditions for environmental contaminants, and to estimate relevant pharmacokinetic parameters (including dose of the active species at the target organs) for both animals and humans.

b) Use/adapt these same PB-PK models to simulate, in both animals and humans, non-uniform exposure scenarios that are relevant to environmental real-life conditions. Determine conditions under which these steady-state pharmacokinetic parameters would not differ significantly from those parameters associated with continuous exposure.

c) Validate model predictions for non-uniform exposures by correlating computer simulations with experimental data.

d) Determine the correlation between pharmacokinetic parameters (including dose of the active species at the target organs) and the toxic effects under various exposure conditions using appropriate indicators of toxicity.

e) Contaminants of interest will include priority chemicals that will be identified by the Ontario Ministry of the Environment and Energy.

Application: PB-PK model(s) would be developed that describe(s) pharmacokinetic parameters of a specified environmental contaminant in animals and human under non-uniform exposure conditions. The model allows definition of exposure patterns and conditions that result in pharmacokinetic parameters that would not differ significantly from those parameters associated with continuous exposure. The models must be verified with experimental data. Correlation (if any) between pharmacokinetic parameters and toxicity would be examined. The correlations could be used in support of standard setting.

Contact: Dr. A. Li-Muller (416-323-5114)

OBJECTIVE 2

To develop more comprehensive and accurate assessments of yield losses in both crop and forest plant species resulting from high ground level concentrations of ozone in Ontario.

Background: Ozone now represents the greatest environmental threat to vegetation in Ontario because of its phytotoxicity and its wide-spread presence. Its effects are not necessarily obvious because reduced plant growth and productivity may not be accompanied by foliar expressions of toxicity (ie. lesions) and because of the general ubiquity of the exposure.

The effects of ozone in forest production in ontario has had very little attention. Slightly better information is available for cultivated crops, but estimates of crop yield losses have been based primarily of research conducted outside of Ontario. Better measures of ozone impacts and associated threshold levels in ambient air are needed for both crop plants and forest species.

Tasks:

a) Set up additional research sites and test species in Ontario as part of the planned EcoResearch Program on terrestrial impacts, sponsored under Environment Canada's Green Plan.

Application: To provide relevant dose-response information for establishing standards and making sound management decisions on necessary hydrocarbon and nitrogen oxide control programs which might have far-reaching economic ramifications.

Contact: Mr. R.G. Pearson (416-323-5102)

OBJECTIVE 3

To assess the potential toxicity of sub-surface contaminants on human and ecological receptors and to characterize the potential exposure pathways involved.

Background: The presence of contaminants in soil is a major concern with respect to human and ecological exposure. Removal of contaminants to acceptable disposal sites is very expensive and occupies space at the site. One alternative is to base the remediation criteria on relevant receptors and exposure pathways, retaining consistent environmental protection even if sub-surface layers have higher concentrations than at the surface.

The concern with this approach is being able to provide assurance that the chemical constituents will remain in place and out of contact with sensitive receptors. Associated with this is a need to know more about how sub-surface contaminants behave (transport, degradation, formation of toxic products) and on how biological systems respond to their presence (root penetration, soil organism response).

Tasks:

a) To assess at suitable sites the environmental behaviour and potential toxicity of contaminants in sub-surface soils. This should include the potential for human and animal exposure and for recycling through deep-rooted plants as well as the transformation and transport of the contaminants as a function of soil properties, topography and drainage of the site.

Application: Such information should be suitable for use in mathematical models for estimating the exposure. The models can be used in exposure pathway decisions as part of a site-specific risk assessment procedure or to modify generic sub-surface criteria.

Contact: Mr. R.G. Pearson (416-323-5102)

RESEARCH OBJECTIVES

3 Rs

GOAL XXII

TO DIVERT FROM DISPOSAL AT LEAST 50 PERCENT BY THE YEAR 2000 BY WASTE REDUCTION, REUSE AND RECYCLING, COMPARED TO 1987 AS A BASE YEAR.

OBJECTIVE 1

To establish examples, or models, of municipal waste reduction, reuse and recycling (3R) unit operation or system efficiencies in existing Ontario projects.

Background: Ontario municipalities are experiencing a wide variation in capital and operating costs for their 3R collection and processing facilities across the province. Information on cost effective unit operations and systems is not readily available.

High costs for inefficient unit operations or systems create a barrier to further expansion of municipal 3R systems and cost cutting measures may lead to decreases in the service levels necessary to sustain effective 3R performance.

Municipalities of various sizes, service levels and service areas need documented examples of cost effective 3R unit operations and systems to use as models to assist in improving the cost effectiveness of their existing 3R collection and processing infrastructures and to encourage further 3R activities.

Tasks:

a) Document cost effective examples of 3R unit operations and systems for different municipal sizes, service levels and service areas in Ontario.

b) Identify common areas of weakness in 3R collection and processing systems to improve efficiencies across the province.

Application: Guidance to improve cost effectiveness of municipal 3R systems and enhanced financial performance from provincial 3R financial assistance programs.

Contact: Mr. N. Ahlberg (416-323-4433)

OBJECTIVE 2

To develop standard, practical and statistically sound sampling and analytical methods for determining the quality of feedstock and compost as set out in the Ministry's Compost Guidelines.

Background: The Ministry's Compost guidelines require raw material and finished compost to be sampled and analyzed for contamination. Standardized methods for sampling have not been established.

As well, standardized analytical methods have not been adopted. As a result, the quality of feedstock and finished compost, as reported, can vary depending on the methods used. Uncertainty of the quality of the finished compost can adversely affect the market for this material.

Tasks:

a) Sampling - determine, based on statistical analysis and field conditions, the most appropriate sampling locations and frequencies as well as sampling protocol, sample size and number of samples; determine, based on existing sample preparation protocols for the required parameters, an appropriate sample preparation method for feedstock and compost samples.

b) Analysis - For each quality parameter set out in the compost guidelines (elements, organic and non-biodegradable materials), determine, based on existing analytical protocols and lab services available, the most appropriate analytical methods for adoption as standard procedures.

Application: Methods for accurately and consistently determining the quality of feedstocks and finished compost.

Contact: Mr. B. Van Opstal (416-325-4435)

OBJECTIVE 3

To determine the seasonal variations in leaf and yard waste composition and the changes required in material processing and compost operating conditions to maintain process efficiencies.

Background: Variations in the relative proportions of organic constituents in leaf and yard waste during the growing season can alter the material preparation needed prior to composting and the operation of compost facilities. High proportions of grass clippings in the spring and leaves in the fall may reduce the need for preprocessing relative to other materials such as brush.

The variation in organic feedstocks also may alter the operating procedures required to maintain proper process conditions. Variations in feedstock composition may sufficiently affect moisture content, physical size, nutrient content and biological availability to require seasonal changes to operating procedures. For example, a high proportion of material that rapidly degrades will require more frequent turning in windrows to maintain aerobic conditions and wetter material may require more bulking agent.

Tasks:

a) Determine the seasonal variation in composition and analytical parameters in leaf and yard waste typically received at municipal leaf and yard waste composting sites.

b) Determine the changes in operating procedures to accommodate the seasonal variations in organic feedstock quality to maintain proper aerobic thermophilic composting conditions.

Application: Guidance to owners/operators of leaf and yard waste composting facilities to ensure environmentally sound and effective operations.

Contact: Mr. N. Ahlberg (416-323-4433)

OBJECTIVE 4

To develop alternative uses for paper mill sludge produced as a by-product of the repulping of secondary paper fibres.

Background:	De-inking capacity in Ontario paper mills is increasing. The by-product produced in the de-inking and paper recycling process is a mixture of short paper fibres, starches, clays and/or inks. It is estimated that approximately 600,000 tonnes of sludge are generated each year and that this figure will double by the year 2000. Northern mills generally use their sludge for co-generation. Over 200,000 tonnes of sludge are disposed each year in southern Ontario. The physical and chemical characteristics of paper mill sludge appear to make it a potentially useful substitute feedstock in the manufacture of some building materials. More research is required to get the ideas to the point of attracting commercial interest.
Tasks:	a) Identify characteristics of paper mill sludge that could meet or exceed industry requirements or standards for feedstocks in various fibre applications. b) Identify applications where required properties are satisfied and test the suitability for selected products.
Application:	Directly contributes to the diversion of a high volume waste from landfill while producing a value-added product made from secondary materials.
Contact:	Ms. B. Alder (416-314-4646)